

A Taxonomic Study of Orders Arcellinida and Gromiida (Protozoa: Sarcomastigophora: Rhizopoda) from Ch'ŏngju Area, Korea

Chung, Wan-Ho and Choi, Jin-Bok

(Department of Biology Education, The Third College, Korea National University of Education,
Ch'ung-buk 363-791, Republic of Korea)

韓國 淸州地域의 有殼變形蟲目 및
有殼絲狀根足蟲目に 대한 分類學的 研究
(原生動物亞界: 肉質鞭毛蟲門: 根足蟲上綱)

鄭 玩 鎬 · 崔 鎮 福
(韓國敎員大學校 第三大學 生物敎育科)

요 약

1988년 9월부터 1989년 8월까지 청주지역에서 채집한 유각변형충 및 유각사상근족충류를 광학현미경 및 주사전자현미경을 사용하여 동정하고 이를 재기재하였다. 동정된 5과 19종 1변종 중에서 *Arcella gibbosa* Penard, *A. polypora* Rhumbler, *Nebela tuberculata* (Wallich), *Diffugia acuminata* var. *inflata* Penard, *D. crassa* Cash and Hopkinson, *D. curvicaulis* Penard, *D. elegans* Penard, *D. lithophila* Penard, *Pontigulasia compressa* (Carter), *P. vas* (Leidy), *Euglypha scutigera* Penard 등 12종 1변종은 한국에서 처음으로 기록되는 종들이다.

Key words: taxonomy, Arcellinida, Gromiida, Korea.

INTRODUCTION

Arcellinida and Gromiida belong to the Rhizopoda, the cytoplasm of which is enclosed by a discrete shell or test, which extrudes lobose or filose pseudopodia. Arcellinida and Gromiida are mostly found in freshwater (Ogden and Hedley, 1980).

The systematic works of Arcellinida and Gromiida began in the early 19th century and many works

of them were accomplished from the late 19th century to the early 20th century by Cash and Hopkinson(1905, 1909, 1915) and Penard(1899). Recently as the ultrastructure of the species were examined with Scanning Electron Microscope(SEM), the characters of the species have been redescribed(Owen and Jones, 1976; Ogden, 1980, 1984; Ogden and Hedley, 1980).

With regard to the record of the Arcellinida and Gromiida from Korea, 18 species in six genera, six families were reported by Kim and Park(1969), Cho and Mizuno (1977) and other's, after Hada(1936) reported six species at Sö lake, Suwön. But there has been little systematic studies on the freshwater testate amoebae. The present paper is a taxonomic study on the freshwater testate amoebae from Ch'öngju area, Ch'ungbuk in South Korea.

MATERIALS AND METHODS

Collections of water and mud samples were made monthly at 10 sites in Ch'öngju area from September, 1988 to August, 1989 (Fig. 1). The materials examined in the present study were extracted from samples by micromanipulator.

The specimens were examined with phase contrast microscope and SEM. Permanent slides for light microscope were made by arranging them with an eyelash mounted on an applicator stick in a dilute solu-

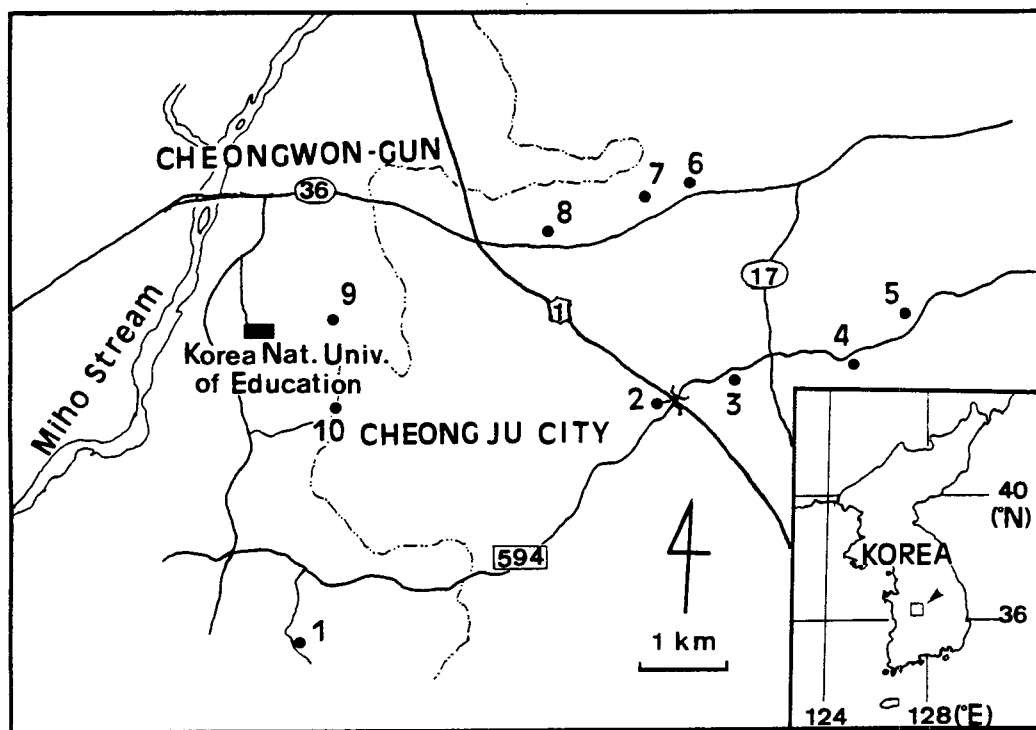


Fig. 1 A map showing the sampling sites. 1, Puryang pond(부량 소류지) ; 2, Karaeul pond(가래울 방죽) ; 3, Hoam pond(호암 방죽) ; 4, Whangsaoul pond(황새울 방죽) ; 5, Kamnamusil pond(감나무실 방죽) ; 6, Hyanggagol pond(향가골 방죽) ; 7, Kwanamjöl pond(관암절 방죽) ; 8, Kangch'on pond(강촌 방죽) ; 9, Chöngmunantteum pond(정문안뜸못) ; 10, Dangsang pond(당산못).

tion of gum tragacanth and allowing them to dry. When being mounted with canada balsam, and covered with cover slip, the specimens remained in proper position to observe. The size of materials were measured by eyepiece micrometer. The photographs of specimens were taken on Kodak Extrachrome 64 film and TP(25) film. To examine the fine structure of the test, the materials were coated by gold and the photographs were taken by SEM at 20KV on Polaroid 52 film.

The classification system in the present study was based on Levine *et al.*(1980) and Ogden and Hedley(1980). Korean name was based on Kang *et al.*(1971) and Kim *et al.*(1988).

RESULT

As a result of the present study, 19 species and one variety in five families belonging to the Arcellinida and Gromiida were identified from Ch'ŏngju area, Korea. Of these twelve species and one variety are newly reported from Korea, they are preceded by an asterisk(*).

'St. number' in Material examined section indicates the sampling sites (shown in Fig. 1), and the number in parenthesis is the number of individuals examined.

Superclass Rhizopoda von Siebold, 근족충 상강
Class Lobosea Carpenter, 1861 엽상근족충 강
Order Arcellinida Kent, 1880 유각변형충 목
Family Arcellidae Ehrenberg, 1843 대접벌레 과
Genus *Arcella* Ehrenberg, 1832 대접벌레 속 (신칭)

1. **Arcella gibbosa* Penard, 1890 꼬마모자벌레 (신칭) (Pl. 1, Figs. A-C)

Arcella gibbosa Penard, 1890 (p. 155, t.v, ff. 96-99) [cited from Cash & Hopkinson, 1905 (p. 121, pl. 15, figs. 11 & 17)].

Arcella gibbosa: Ogden & Hedley, 1980 (p. 38, pl. 8).

Arcella vulgaris var. *gibbosa* :West,1901 (p.314) [cited from Cash & Hopkinson, 1905 (p. 121, pl. 15, figs. 11 & 17)].

Arcella vulgaris var. *gibbosa*: Cash & Hopkinson, 1905 (p. 121, pl. 15, figs. 11 & 17).

Material examined: St.8 (2), Nov. 23, 1988; St.10 (2), Oct. 5, 1988.

Description: Shell yellow or brown in color, circular and domed or hemispherical in lateral view. Apertural surface and basal collar smooth (Pl. 1, Fig. A), but aboral hemisphere with a series of regular depressions (Pl. 1, Figs. B and C). Shell surface composed of many protein alveoli and with numerous small pores (arrow in Pl. 1, Fig. B). Aperture invaginated, circular, central and with distinct rim or lip (Pl. 1, Fig. A).

Dimensions: Diameter of shell 70-80 μ m; Depth 48-51 μ m; Diameter of aperture 15-17 μ m.

Distribution: Europe, Africa, North America, Korea.

Remarks: This species is similar to *Arcella conica* and *A. bathystoma*. but it can be distinguished from them by the small size of aperture and many angular facets.

2. **Arcella polypora* Penard, 1890 다공접시벌레 (신칭) (Pl. 1, Fig. D)

Arcella polypora Penard, 1890 [cited from Ogden & Hedley, 1980 (p. 42, pl. 10)].

Arcella polypora: Ogden & Hedley, 1980 (p. 42, pl. 10).

Material examined: St.2 (3), May 3, 1989; St.5 (5), May 3, 1989; St.10 (2), Oct. 5, 1988; (3), Jun.

15, 1989.

Description: Shell brown in color, circular in shape and with shallow conical aboral region. Apertural surface of shell usually smooth, but remainder of shell with numerous small pores. Aperture slightly invaginated, central, circular, bordered by small lip and about sixty large pores (Pl. 1, Fig. D, arrow).

Dimensions: Diameter of shell 96-100 μ m; Depth 20-26 μ m; Diameter of aperture 40-48 μ m.

Distribution: Europe, Africa, Korea.

Remarks: This species is similar to *Arcella discoides* and *A. artocrea* in shape, but it can be distinguished from them by the large apertural size and the distribution of many pores around the aperture.

Family Centropyxidae Jung, 1942 베레모벌레 과 (신창)

Genus *Centropyxis* Stein, 1859 베레모벌레 속 (신창)

3. *Centropyxis aculeata* (Ehrenberg, 1830) 뿔베레모벌레 (신창) (Pl. 2, Fig. A)

Arcella aculeata Ehrenberg, 1830 (p. 40) [cited from Cash & Hopkinson, 1905 (p. 132, pl. 16, figs. 10-14)].

Centropyxis aculeata: Stein, 1859 (p.43) [cited from Cash & Hopkinson, 1905 (p. 132, pl. 16, figs. 10-14)].

Centropyxis aculeata: Cash & Hopkinson, 1905 (p. 132, pl. 16, figs. 10-14); Ogden & Hedley, 1980 (p. 46, pl. 12); Mizuno, 1987 (p. 27, pl. 8, figs. 5-6); Kudo, 1954 (p. 484, fig. 204g); Hall, 1961 (p. 247, fig. 5. 32. N); Jahn et al., 1979 (p. 146, figs. 256. A-B).

Material examined: St.2 (12), May 3, 1989; St.3 (3), Mar. 29, 1989; St.4 (2), May 3, 1989; St.5 (3), Mar. 29, 1989; St.6 (7), May 3, 1989; St.7 (5), May 3, 1989; St.9 (2), Nov. 7, 1988; (3), Jun. 19, 1989; St.10 (2), Sep. 13, 1988.

Description: Shell yellow or brown in color, ovoid or circular in shape, and usually with four or more lateral spines (Pl. 2, Fig. A). In lateral view beret-shape, shell spherical and tapering towards aperture. Shell surface rough, except for smooth region around aperture, and often covered with sand-grains or diatom frustules. Aperture invaginated, oval and sub-terminal.

Dimensions: Length of shell 99-167 μ m; Breadth of shell 87-160 μ m; Depth of shell 46-55 μ m; Diameter of aperture 43-68 μ m.

Distribution: Cosmopolitan.

Remarks: This species is similar to *Centropyxis eornis* and *C. discoides* in shape, but it can be distinguished from them in the presence of lateral spines.

4. **Centropyxis eornis* (Ehrenberg, 1841) 베레모벌레 (신창) (Pl. 1, Figs. E-F)

Arcella eornis Ehrenberg, 1841 (p. 368, t.i, f. 9) [cited from Cash & Hopkinson, 1905 (p. 136, pl. 16, fig. 16)].

Centropyxis eornis: Leidy, 1879 (p. 163) [cited from Cash & Hopkinson, 1905 (p. 136, pl. 16, fig. 16)].

Centropyxis eornis: Ogden & Hedley, 1980 (p. 46, pl. 12)].

Centropyxis aculeata var. *eornis*: Leidy, 1879 (p. 181, t. xxx, ff. 20-34; t. xxxi, ff. 33, 34; t. xxxii, ff. 35, 36) [cited from Cash & Hopkinson, 1905 (p. 136, pl. 16, fig. 16)].

Centropyxis aculeata var. *eornis*: Cash & Hopkinson, 1905 (p. 136, pl. 16, fig. 16).

Material examined: St.5 (1), May 3, 1989; St.10 (4), May 24, 1989.

Description: Shell brown in color and usually circular in shape (Pl. 1, Fig. F). In lateral view beret-shape (Pl.1, Fig. E), aboral region spherical and tapering from mid-body to apertural lip. Shell rough, but apertural surface usually with covering of organic cement overlying irregular mineral particles. Aperture in-

vaginated, oval or circular, sub-terminal with thick apertural rim.

Dimensions: Length of shell 170-192 μ m; Breadth of shell 168-175 μ m; Depth of shell 72-80 μ m; Diameter of aperture 70-89 μ m.

Distribution: Cosmopolitan.

Remarks: Variations in this species appear to be restricted to size and shape.

Family Hyalospheniidae Schulze, 1877

Genus *Lesquereusia* Schlumberger, 1845 또아리벌레 속 (신칭)

5. **Lesquereusia modesta* Rhumbler, 1895 모래알또아리벌레 (신칭) (Pl. 2, Figs. B-C)

Lesquereusia modesta Rhumbler, 1895 (p. 101, t. iv, f. 2)) [cited from Cash & Hopkinson, 1909 (p. 70, pl. 22, fig. 15; pl. 22, fig. 9)].

Lesquereusia modesta: Cash & Hopkinson, 1909 (p. 70, pl. 22, fig. 15; pl. 22, fig. 9); Ogden and Hedley, 1980 (p. 84, pl. 31).

Lesquereusia modesta var. *caudata*: Laminger, 1973 (p. 268, fig. 8e-f).

Diffugia spiralis: Mizuno, 1987 (p. 25, pl. 7, fig. 4).

Material examined: St.1 (2), Nov. 23, 1988; (2), May 3, 1989; St.5 (1), Nov. 23, 1988; St.7 (3), May 3, 1989; St.10 (3), Sep. 10, 1988; (7), Apr. 10, 1989.

Description: Shell colorless and opaque, circular in shape with unsymmetrical neck, and slightly compressed laterally. Shell incrustated sometimes very thickly with sand-grains, having short protuberance, and narrowing evenly to truncated aperture. Aperture terminal, circular and bordered by small particles of quartz (Pl. 2, Fig. C).

Dimensions: Length of shell, including the neck 120-151 μ m; Breadth of shell 103-129 μ m; Diameter of aperture 31-46 μ .

Distribution: Cosmopolitan.

Remarks: This species is frequently found mostly in ponds with the larger forms of *Diffugia*. The test is generally more compressed than that of *L. spiralis*, and the tube or neck is thicker and shorter than that of *L. spiralis*.

Genus *Nebela* Leidy, 1875.

6. **Nebela tuberculata* (Wallich, 1864) 막대산딸기벌레 (신칭) (Pl. 2, Figs. D-F)

Diffugia proteiformis sub-sp. *globularis* var. *tuberculata* Wallich, 1864 (p. 241, t. xv, f. 4g; t. xvi, f. 18) [cited from Cash & Hopkinson, 1909 (p. 159, figs. 105, 106)].

Diffugia tuberculata: Archer, 1867 (p. 177) [cited from Cash & Hopkinson, 1909 (p. 159, figs. 105, 106)].

Diffugia tuberculata: Cash & Hopkinson, 1909 (p. 159, figs. 105, 106).

Nebela tuberculata: Owen & Jones, 1976 (p. 486, figs. 5-9).

Material examined: St.10 (2), Sep. 10, 1988; (3), Jun. 15, 1989.

Description: Shell brown in color, ovoid in shape, with short neck. Surface characterized with almost regular arrangement of small protuberances. Protuberances with short silicious rods, and long silicious rods observed between them. Aperture circular and bordered by narrow collar with 4-6 lobes cemented with organic material.

Dimensions: Length of shell 115-120 μ m; Breadth of shell 110-115 μ m; Diameter of aperture 36-40 μ m.

Distribution: North America, Korea.

Remarks: This species is similar to *Diffugia* sp. listed in this paper in shape. But the SEM photograph shows the conspicuous silicious rods on the surface.

Family diffugiidae Wallich, 1864 꽃병벌레 과

Genus *Diffugia* Leclere, 1815 꽃병벌레 속 (신칭)

7. *Diffugia acuminata* Ehrenberg, 1838 뽕죽꼬리원통벌레 (신칭) (Pl. 3, Figs. A, C)

Diffugia acuminata Ehrenberg, 1838 (p. 131, t. ix, f. 3) [cited from Cash & Hopkinson, 1909 (p. 19, pl. 18, figs. 12-13)].

Diffugia acuminata: Cash & Hopkinson, 1909 (p. 19, pl. 18, figs. 12-13); Ogden & Hedley, 1980 (p. 118, pl. 48); Mizuno, 1987 (p. 26, pl. 7).

Material examined: St.1 (5), Nov. 23, 1988; St.3 (4), Nov. 23, 1988; (3), Mar. 29, 1989; St.4 (1), Nov. 23, 1988; St.5 (1), Nov. 23, 1988; St.8 (5), Nov. 11, 1988; St.10 (4), Oct. 5, 1988; (1), Nov. 11, 1988; (11), Apr. 10, 1989.

Description: Shell brown in color, usually oblong, oval, pyriform, or cylindrical in shape, somewhat enlarged posteriorly. Shell length three or four times as long as breadth, crown tapering or acuminate, neck narrowing slightly to rather wide circular mouth. Surface rough and covered with quartz particles. Aperture covered with organic cement (Pl. 3, Fig. C).

Dimensions: Length of shell, 193-300 μ m; Breadth of shell 64-81 μ m; Diameter of aperture 37-55 μ m.

Distribution: Cosmopolitan.

Remarks: Cash and Hopkinson(1909) noted that there was such a gradation of shape and size between specimens that they should not be considered as varieties. Nevertheless, they listed one species *Diffugia acuminata*, and two varieties *Diffugia acuminata* var. *inflata* and *D. acuminata* var. *curvata*.

8. **Diffugia acuminata* var. *inflata* Penard, 1899 뽕죽꼬리달걀벌레 (신칭) (Pl. 3, Figs. B, D-E)

Diffugia acuminata var. *inflata* Penard, 1899 (p. 29, pl. 3, fig. 3); Cash & Hopkinson, 1909 (p. 23, pl. 18, fig. 14).

Material examined: St.3 (3), May 3, 1989; St.4 (5), May 3, 1989; St.7 (2), May 3, 1989; St.9(7), Apr. 10, 1989.

Description: Test of thin chitinous materials, incrustated with muddy particles, shorter than type species and broader in proportion, breadth being little more than half the average length, swollen above and suddenly contracted towards acute or conical apex. Structure, in its lower half, narrowed convexly downwards to truncated, circular aperture, which neither expanded nor collared.

Dimensions: Length of shell 223-263 μ m; Breadth of shell 138-143 μ m; Diameter of aperture 58-60 μ m.

Distribution: Cosmopolitan.

Remarks: This species is similar to the type species in shape in that it has acuminate aboral region and the smooth outline of aperture, but it can be distinguished on wider breadth and the smooth outline of shell.

In this study, the material with two spines is examined, which was not described by Penard(1899) and Cash and Hopkinson(1909).

9. *Diffflugia corona* Wallich, 1864 왕관벌레 (신 칭) (Pl. 4, Figs. A-B)

Diffflugia corona Wallich, 1864 (p. 144, t. xv, f. 4b, c; t. xvi, ff. 19, 20) [cited from Cash & Hopkinson, 1909 (p. 49, pl. 22, figs. 3-7)].

Diffflugia corona: Cash & Hopkinson, 1909 (p. 49, pl. 22, figs. 3-7); Hall, 1961 (p. 9, fig. 1.5F); Jahn et al., 1979 (p. 146, fig. 255C); Ogden & Hedley, 1980 (p. 128, pl. 53); Mizuno, 1987 (p. 25, pl. 7, figs. 1-2).

Material examined: St.1 (3), May 3, 1989; St.2 (5), Nov. 23, 1988; (5), May 3, 1989; St.3 (6), Mar. 29, 1989; St.4 (7), May 3, 1989; St.5 (1), Nov. 23, 1988; (7), Mar. 29, 1989; St.8 (10), May 3, 1989; St.10 (14), Sep. 13, 1988; (10), Oct. 5, 1988; (1), Nov. 11, 1988; (5), May 24, 1989.

Description: Shell brown in color, spherical or ovoid in shape and with about 10 aboral spines, which protruded radially. In lateral view crown-shape. Transverse section and oral view circular. Surface incrustated with quartz particles, with small pieces being cemented into gaps between large pieces to produce relatively uniform surface. Aperture circular, its border multilobate or multidentate, with variable number of lobes from 8 to 12. Pseudopodia 3-5 in number, branching, long and thin.

Dimensions: Length of shell 133-168 μ m; Breadth of shell 129-160 μ m; Diameter of aperture 64-78 μ m.

Distribution: Europe, Africa, South and North America, Japan, Korea.

Remarks: Several species of *Centropyxis* are very similar to this species in the presence of spines, while this species has a aperture at terminal of the shell and a multidentate collar. In lateral view, the formers look like a beret-shape, but this species is subspherical or ovoid in shape.

Cash and Hopkinson(1909) described that the number of lobes was 12-20. However present species showed that the number of lobes varied from 8 to 12.

10. **Diffflugia crassa* Cash & Hopkinson, 1909 큰자루벌레 (신 칭) (Pl. 4, Figs. C-E)

Diffflugia crassa Cash & Hopkinson, 1909 (p. 13, pl. 18, figs. 1-3).

Material examined: St.8 (3), Nov. 16, 1988; (5), May 3, 1989; St.9 (4), Feb. 16, 1989; (15), May 3, 1989.

Description: Test large, composed of coarse sand-grains, dense and opaque, compressed, and very broad proportionately to length. Crown arched and provided with 1-4 short mamillary protuberances or conical blunt spines, which not always symmetrically situated nor of uniform length. Aperture circular, and with short cylindrical neck. Pseudopodia massive, branching or lobed, and penetrated by granular endoplasm.

Dimensions: Length of shell, including the protuberances, 348-414 μ m; Breadth of shell 215-300 μ m; Diameter of aperture 67-78 μ m.

Distribution: British Isles, Korea.

Remarks: This species is similar in narrow lateral view (Pl. 4, Fig. D) to *Diffflugia oblonga*, but its transverse section is elliptic, in this respect it differs from all other forms of *D. oblonga*.

11. **Diffflugia curvicaulis* Penard, 1899 굽은고리원통벌레 (신 칭) (Pl. 5, Figs. A-B)

Diffflugia curvicaulis Penard, 1899 (p. 36, pl. 3, figs. 3-6); Cash & Hopkinson, 1909 (p. 29, pl. 19, fig. 8); Ogden & Hedley, 1980 (p. 130, pl. 54).

Material examined: St.1 (10), Nov. 23, 1988; St.3 (3), Mar. 29, 1989; (11), May 3, 1989; St.4 (5), May 3, 1989; St.5 (3), Mar. 29, 1989; St.8 (2), Nov. 16, 1988; St.9 (3), Nov. 7, 1988; (1), Jan. 17, 1989; St.10 (2), Apr. 10, 1989; (13), May 24, 1989

Description: Shell colorless or borwn in color, transparent, elongate or ovoid in shape, circular in transverse section. Aboral region terminating with tubular horn which often curved and perforated at its apex. Organism not completely filling interior of test; one or two attachment-threads visible in posterior part. Aperture circular and surrounded by rim composed of small particles.

Dimensions: Length of shell 280-360 μ m; Breadth of shell 55-106 μ m; Diameter of aperture 40-52 μ m.

Distribution: Europe, Africa, Korea.

Remarks: Cash and Hopkinson (1909) considered that this species differed from *Diffflugia acuminata* only in the form of the terminal horn. However it was distinguished from *D. acuminata* and *D. elegans* in the smoothness of the shell, the shape of the horn, and the form of the aperture with small particles (Ogden and Hedley, 1980).

12. **Diffflugia elegans* Penard, 1890 잘록허리원통벌레 (신 칭) (Pl. 5, Figs. C-D)

Diffflugia elegans Penard, 1890 (p. 140, t. iv, ff. 7, 8) [cited from Cash & Hopkinson, 1909 (p. 28, pl. 20, figs. 2-5)].

Diffflugia elegans: Ogden & Hedley, 1980 (p. 132, pl. 55).

Diffflugia bacilliarum var. *elegans*: Cash & Hopkinson, 1909 (p. 28, pl. 20, figs. 2-5).

Material examined: St.1 (1), Nov. 23, 1988; St.4 (1), Nov. 23, 1988; St.7 (12), May 3, 1989; St.8 (2), May 3, 1989.

Description: Shell brown in color, transparent, very variable, with rounded crown which acuminate in shape or irregularly-formed, terminated by tubular horn, and with distinct constriction posterior to aperture. In transverse section circular, and surface composed of sand-grains. Aperture circular. Pseudopodia simple, not numerous, thrust outwards through mass of loose sandy particles, which nearly always surround orifice.

Dimensions: Length of shell 120-208 μ m; Breadth of shell 60-100 μ m; Diameter of aperture 30-46 μ m.

Distribution: Cosmopolitan.

13. *Diffflugia gramen* Penard, 1902 작은세잎벌레 (신 칭) (Pl. 5, Figs. E-F)

Diffflugia gramen Penard, 1902 (p. 281, ff. 1-6) [cited from Cash & Hopkinson, 1909 (p. 48, pl. 22, figs. 1-2)].

Diffflugia gramen: Cash & Hopkinson, 1909 (p. 48, pl. 22, figs. 1-2); Hada, 1936 (p. 4, fig. 9); Ogden, 1980 (p. 125, figs. 1-6); Ogden & Hedley, 1980 (p. 136, pl. 57).

Material examined: St.3 (5), Mar. 29, 1989; (5), May 3, 1989; St.4 (5), May 3, 1989; St.10 (11), May 24, 1989; (17), Jun. 15, 1989.

Description: Shell light borwn or purplish-grey in color, almost transparent, spherical or ovoid. Surface rough, covered with sand-grains, but like *D. corona* gaps between large apticles often filled with smaller fragment. Neck absent. Aperture trilobed and surrounded by rim of small particles cemented together. Surface near aperture pitted. Pseudopodia digitate.

Dimensions: Length of shell 78-98 μ m; Breadth of shell 64-83 μ m; Diameter of aperture 24-38 μ m.

Distribution: Cosmopolitan.

Remarks: This species is very similar to *Diffflugia lobostoma* in the shape of the test and aperture. However *D. lobostoma* has a larger test than that of this species.

14. **Diffflugia lithophila* Penard, 1902 짧은목세알벌레 (신 칭) (Pl. 6, Fig. A)

Diffflugia lithophila Penard, 1902 [cited from Ogden & Hedley, 1980 (p. 142, pl. 60)].

Diffflugia lithophila: Ogden & Hedley, 1980 (p. 142, pl. 60).

Material examined: St.2 (2), May 3, 1989; St.3 (11), May 3, 1989; St.6 (7), May 3, 1989; St.7 (3), Mar. 29, 1989; (5), May 3, 1989.

Description: Shell brown in color, ovoid with slight constriction near aperture forming small collar, and circular in transverse section (Pl. 6, Fig. A). Shell composed of small quartz particles and some diatom shells. Aperture circular and having small collar with uneven outline.

Dimensions: Length of shell 101-129 μ m; Breadth of shell 83-106 μ m; Diameter of aperture 36-46 μ m.

Distribution: Europe, Africa, Korea.

Remarks: This species is similar to *Diffflugia gramen* in shape, but it can be distinguished from *D. gramen* in the length of shell, circular aperture, and small collar.

15. *Diffflugia oblonga* Ehrenberg, 1838 방망이벌레 (신칭) (Pl. 6, Figs. D-E)

Diffflugia oblonga Ehrenberg, 1838 (p. 131, t. ii. f. 2a-d) [cited from Cash & Hopkinson, 1909 (p. 4, pl. 17, figs. 1-3, 7 & 8p; pl. 19, figs. 3-4)].

Diffflugia oblonga: Cash & Hopkinson, 1909 (p. 4, pl. 17, figs. 1-3, 7 & 8; pl. 19, figs. 3-4); Kudo, 1954 (p. 482, fig. 204a); Jahn et al., 1979 (p. 146, fig. 255B); Ogden & Hedley, 1980 (p. 148, pl. 63).

Diffflugia pyriformis: Mizuno, 1987 (p. 25, pl. 7, fig. 9); Hall, 1961 (p. 247, fig. 5.32A).

Material examined: St.1 (2), Nov. 23, 1988; St.2 (2), Nov. 23, 1988; (7), May 3, 1989; St.3 (3), Nov. 23, 1988; (7), Mar. 29, 1989; (3), May 3, 1989; St.4 (16), May 3, 1989; St.5 (5), Nov. 23, 1988; (12), Mar. 29, 1989; St.6 (5), May 3, 1989; St.7 (15), Mar. 29, 1989; (6), May 3, 1989; St.8 (6), Nov. 16, 1988; (8), May 3, 1989; St.9 (3), Nov. 7, 1988; (3), Jan. 17, 1989; (21), Jun. 19, 1989; St.10 (3), Sep. 10, 1988; (3), Oct. 5, 1988; (2), Jan. 17, 1989; (12), Apr. 10, 1989; (17), May 24, 1989; (23), Jun. 15, 1989.

Description: Shell brown in color, variable in outline and size; typically oblong or pyriform in shape; symmetrical, whether viewed longitudinally or transversely; crown arched, sides tapering with more or less convexity to truncated mouth, or narrowing suddenly to form short cylindrical neck. Surface incrustated with opaque sand-grains. Circular aperture surrounded by small particles cemented together (Pl. 6, Fig. E).

Dimensions: Length of shell 193-276 μ m; Breadth of shell 87-152 μ m; Diameter of aperture 41-67 μ m.

Distribution: Cosmopolitan.

Remarks: This species is one of the species which are most frequently collected in the ooze of pond. It distinguished from *Diffflugia longicollis* only in the size of shell. This species is large (about 200 μ m or more), but *D. longicollis* is small (about 100 μ m or less).

16. *Diffflugia* sp. 모래알산딸기벌레 (신칭) (Pl. 6, Figs. B-C)

Material examined: St.7 (1), May 3, 1989; St.10 (2), Jun. 15, 1989.

Description: Test brown in color, ovoid laterally, circular in transverse section, mamillated throughout with subhemispherical elevations exteriorly, surface a strawberry-shape sometimes masked by sand-grains of irregular size. Crown spherical, sides tapering with concave curve to aperture which about one-third of diameter of test, with narrow lip or collar with 6-8 lobes.

Dimensions: Length of shell 120-129 μ m; Breadth of shell 92-108 μ m; Diameter of aperture 42-46 μ m.

Remarks: We think this species as the same speices as *Diffflugia tuberculata* (Wallich, 1864) reported in the paper by Ogden and Hedley(1980). According to Owen and Jones(1976), *Diffflugia tuberculata* has

a characteristic feature of Genus *Nebela* and they transferred this species to *Nebela tuberculata*. Because Ogden and Hedley (1980) used the name of *Diffflugia tuberculata* on the identification of their specimens without citing Owen and Jone's paper, and we think, the two species *Nebela tuberculata* and *Diffflugia tuberculata* are different, we can't use the same specific name of *tuberculata* under the different generic name. In the present study, we list *Diffflugia* sp. until the taxonomic status of the two species are settled.

17. *Diffflugia urceolata* Carter, 1864 넓은목도리벌레 (신칭) (Pl. 7, Figs. A-B)

Diffflugia urceolata Carter, 1864 (pp. 27, 37, t.i. f.7) [cited from Cash & Hopkinson, 1909 (p. 39, pl. 21, figs. 10-12)].

Diffflugia urceolata: Cash & Hopkinson, 1909 (p. 39, pl. 21, figs. 10-12); Kudo, 1954 (p. 483, fig. 204b); Jahn et al., 1979 (p. 146, fig. 255A); Ogden & Hedley, 1980 (p. 158, pl. 68); Mizuno, 1987 (p. 26, pl. 7, fig. 10).

Material examined: St.9 (5), Jun. 19, 1989; St.10 (3), Sep. 13, 1988.

Description: Shell brown in color, ovoid, rotund in shape, opaque, occasionally with irregular blunt collar which clear and slightly recurved and made of small particles. Body of shell comparatively smooth with quartz-grains and other opaque minerals.

Dimensions: Length of shell 260-272 μ m; Breadth of shell 231-233 μ m; Diameter of aperture 100-110 μ m.

Distribution: North America, West Africa, Japan, Korea.

Remarks: This species is rarely found at the sub-merged plants in swampy ponds, but so large that it can be observed easily in the low magnification about $\times 50$. Cash and Hopkinson(1909) mentioned that this species varied in the presence of aboral protuberances and the body size.

Genes *Pontigulasia* Rhumbler, 1895 물통벌레 속 (신칭)

18. **Pontigulasia compressa* (Carter, 1864) 납작물통벌레 (신칭) (Pl. 7, Figs. C-E)

Diffflugia compressa Carter, 1864 (p. 22, t. i, ff. 5, 6) [cited from Cash & Hopkinson, 1909 (p. 62, pl. 23, figs. 3-5)].

Pontigulasia compressa: Rhumbler, 1905 (p. 105, t. iv. f. 13) [cited from Cash & Hopkinson, 1909 (p. 62, pl. 23, figs. 3-5)].

Pontigulasia compressa: Cash & Hopkinson, 1909 (p. 62, pl. 23, figs. 3-5); Ogden & Hedley, 1980 (p. 162, pl. 70).

Material examined: St.3 (5), Mar. 29, 1989; St.4 (5), May 3, 1989; St.7 (3), May 3, 1989; St.8 (2), Mar. 29, 1989; (7), May 3, 1989; St.10 (8), Apr. 10, 1989; (11), Jun. 15, 1989.

Description: Test brown in color, large, ovoid or roundish pyriform in shape, nearly as broad as long, and unequally compressed, body (above the constriction) broadly reniform, its convex surface forming crown of test. Short neck joining body in a V-shaped wedge, circular in transverse section. Aperture circular or ovoid, and internally at junction of neck with perforated diaphragm.

Dimensions: Length of shell 131-157 μ m; Breadth of shell 87-102 μ m; Diameter of aperture 35-44 μ m.

Distribution: Europe, South America, Korea.

Remarks: It may be remarked that the general outline of this species, apart from the constriction which is characteristic of *Pontigulasia*, is that of the commoner forms of *Diffflugia oblonga*.

19. **Pontigulasia vas* (Leidy, 1874) 조롱박벌레 (신칭) (Pl. 8, Figs. A-B)

Diffflugia vas Leidy, 1874 (p. 155) [cited from Cash & Hopkinson, 1909 (p. 59, pl. 23, fig. 1)].

Pontigulasia vas: Schouteden, 1906 (p. 338) [cited from Cash & Hopkinson, 1909 (p. 59, pl. 23, fig. 1)].

Pontigulasia vas: Cash & Hopkinson, 1909 (p. 59, pl. 23, fig. 1); Kudo, 1954 (p. 484, fig. 205b); Jahn et al.,

1979 (p. 146, fig. 255A).

Material examined: St.9 (5), Feb. 16, 1989.

Description: Test brown in color, round or ovoid in lateral view, not compressed, constriction deep and well-marked, sometimes fortified by comparatively large quartz-grains, neck oval, or, from slight inflation immediately below constriction tapering down to aperture narrowed and truncated. Surface of body more or less thickly incrustated with sand-grains. Thin neck transparent, covered with small particles. Aperture circular, bordered by small quartz-grains.

Dimensions: Length of shell 222-257 μ m; Breadth of shell 137-177 μ m; Diameter of aperture 38-41 μ m.

Distribution: British Isles, Switzerland, Korea.

Remarks: This species appears to be rare than *P. compressa*. Cash and Hopkinson(1909) recorded the dimensions of this species as 125-179 μ m in length and noted that the length is very variable. In present work, all materials examined were longer than Cash and Hopkinson's.

Class Filosea Leidy, 1879 사상근족충 강

Order Gromiida Claparede and Lachmann, 1859 유각근족충 목

Family Euglyphidae Wallich, 1864 붕어벌레 과 (신칭)

Genus *Euglypha* Dujardin, 1840 붕어벌레 속 (신칭)

20. **Euglypha scutigera* Penard, 1911 방패비늘붕어벌레 (신칭) (Pl. 8, Figs. C-F)

Euglypha scutigera Penard, 1911 (pp. 41-42, pl. iv, f. 20) [cited from Cash et al., 1915 (p. 7, pl. 33, figs. 1-2)].

Euglypha scutigera: Cash et al., 1915 (p. 7, pl. 33, figs. 1-2).

Material examined: St.10 (27), Sep. 13, 1988).

Description: Test hyaline, oviform, circular in transverse section, formed of scutiform siliceous plates arranged in alternation longitudinal rows regularly imbricated, surface glabrous. Aperture terminal, circular, bordered by two rows of finely-serrated scales (Pl. 8, Fig. E), ten to thirteen in each row. Pseudopodia filiform, tapering, branching and anastomosing.

Dimensions: Length of shell 58-70 μ m; Breadth of shell 30-34 μ m; Diameter of aperture 15-20 μ m.

Distribution: British Isles, Korea.

Remarks: This species is very similar to *Euglypha acanthophora* and *E. tuberculata* in shape, but it can be distinguished from them in the absence of spines and the shape of the shell plate.

ABSTRACT

The Arcellinida and Gromiida (Protozoa: Sarcomastigophora: Rhizopoda) inhabiting the freshwater in Ch'öngju area were systematically investigated. Collections of samples were made from September, 1988 to August, 1989 at 10 sites located in Ch'öngju area, Korea. As a result, 19 species and one variety in five families were identified, of which 12 species and one variety were newly recorded from Korea: *Arcella gibbosa* Penard, *A. polypora* Penard, *Centropyxis ecomis* (Ehrenberg), *Lesquereusia modesta* Rhumbler, *Nebela tuberculata* (Wallich), *Diffugia acuminata* var. *inflata* Penard, *D. crassa* Cash and Hopkinson, *D. curvicaulis* Penard, *D. elegans* Penard, *D. lithophila* Penard, *Pontigulasia compressa* (Carter), *P. vas* (Leidy), *Euglypha scutigera* Penard. The identified species were redescribed with photographs.

REFERENCES

- Cash, J. and J. Hopkinson, 1905. The British freshwater Rhizopoda and Heliozoa. Vol. I Rhizopoda, part 1. The Ray Society, London, 150 pp., 16 pls.
- Cash, J. and J. Hopkinson, 1909. The British freshwater Rhizopoda and Heliozoa. Vol. II Rhizopoda, part 2. The Ray Society, London, 166 pp., 16 pls.
- Cash, J., G. H. Wailes and J. Hopkinson, 1915. The British freshwater Rhizopoda and Heliozoa. Vol. III Rhizopoda, part 3. The Ray Society, London, 156 pp., 24 pls.
- Cho, K. S. and T. Mizuno, 1977. Comparison of limnological conditions and plankton communities in the Uiam Lake consisting of the different river systems. The Korean J. Limn., **10**: 73-85. (In Korean)
- Hada, Y., 1936. The plankton of Lake Seiko, Suigen in autumn. J. of Chosen Nat. Hist. Society, **21**: 1-11. (In Japanese)
- Hall, R. P., 1961. Protozoology. Modern Asia Edition. Charles E. Tuttle C. Tokyo, 682 pp.
- Jahn, T. L., E. C. Bovee and F. F. Jahn, 1979. How to know the Protozoa. Second ed. The Pictured Key Nature Series, 279 pp.
- Kang, Y. S., C. H. Kim, H. S. Kim, G. Y. Paik, B. C. Weon, D. S. Lee, B. S. Cho and G. C. Choi, 1971. Nomina Animalium Koreanorum (3) Invertebrata. The Zoological Society of Korea: 31-39. (In Korean)
- Kim, H. S., C. E. Lee and B. J. Rho, 1988. Animal taxonomy. Ziphyen-sa Publishing Co., Seoul, 502 pp. (In Korean).
- Kim, H. S. and K. B. Park, 1969. Studies on the pollution and zooplanktons of the Han River as the source of the water supply for producing good quality water. Research of Ministry of Sci. and Tech., 69-34, Part 1: 25-44. (In Korean)
- Kudo, R. R., 1954. Protozoology. 4th ed. Charles C. Thomas, Springfield, Ill., 1174 pp.
- Laminger, H., 1973. The testacean fauna (protozoa, Rhizopoda) in the surrounding of Obertauern (Salzburg, Austria). Arch. Protistenk. **115**: 253-270. (In German)
- Levine, N. D., J. O. Corliss, F. E. G. Cox, G. Deroux, J. Grain, B. M. Honigberg, G. F. Leedale, A. R. Loeblich, J. Lom III, D. Lynn, E. G. Merinfeld, F. C. Page, G. Poljansky, V. Sprague, J. Vavra, and F. G. Wallace, 1980. A newly revised classification of the Protozoa. J. Protozool., **27**, 1 : 37-58.
- Mizuno, T., 1987. Illustrations of the freshwater plankton of Japan. Revised ed. Hoikusha, Osaka, 353 pp. (In Japanese).
- Ogden, C. G., 1980. Notes on some Diffugiidae from Norfolk (Rhizopoda, Protozoa). Bull. Br. Mus. Nat. Hist. (Zool.), **39**, 5 : 125-138.
- Ogden, C. G., 1984. Notes on testate amoeba (Protozoa: Rhizopoda) from Lake Vlasina, Yugoslavia. Bull. Br. Mus. Nat. Hist. (Zool.), **47**, 5 : 241-263.
- Ogden, C. G. and R. H. Hedley, 1980. An atlas of freshwater testate amoebae. Br. Mus. (Nat. Hist.), Oxford, 222 pp.
- Owen, G. III and E. E. Jones, 1976. *Nebela tuberculata* comb. nov. (Arcellinida), its history and ultrastructure. J. Protozool., **23**, 4 : 485-487.
- Penard, E., 1899. Les Rhizopodes de faune profonde dans le Lac Léman. Rev. Suisse de Zool., T., **7**: 1-142. (In French)

RECEIVED: 28 SEPTEMBER 1989

ACCEPTED: 20 OCTOBER 1989

EXPLANATION OF PLATES

PLATE 1

- Figs. A-C.** *Arcella gibbosa* Penard. A, apertural view; B, surface of shell showing angular facets with collapsed alveoli and small pores (arrow); C, aboral view by light microscope.
- Fig. D.** *Arcella polypora* Penard. Apertural view by light microscope, illustrating the arrangement of the pores surrounding aperture (arrow).
- Figs. E-F.** *Centropyxis ecornis* (Ehrenberg). E, lateral view; F, apertural view.

PLATE 2

- Fig. A.** *Centropyxis aculeata* (Ehrenberg). Apertural view by light microscope.
- Figs. B-C.** *Lesquereusia modesta* Rhumbler. B, broad lateral view; C, apertural view.
- Figs. D-F.** *Nebela tuberculata* (Wallich). D, apertural view; E, lateral view; F, part of surface to show the arrangement of the siliceous rods.

PLATE 3

- Figs. A,C.** *Diffflugia acuminata* Ehrenberg. A, lateral view; C, apertural view.
- Figs. B, D-E.** *Diffflugia acuminata* var. *inflata* Penard. B, apertural view; D, lateral view; E, lateral view illustrating two aboral spines.

PLATE 4

- Figs. A-B.** *Diffflugia corona* Wallich. A, lateral view; B, apertural view.
- Figs. C-E.** *Diffflugia crassa* Cash and Hopkinson. C, broad lateral view; D, narrow lateral view; E, view of aperture.

PLATE 5

- Figs. A-B.** *Diffflugia curvicaulis* Penard. A, lateral view; B, view of aperture.
- Figs. C-D.** *Diffflugia elegans* Penard. C, lateral view; D, view of aperture.
- Figs. E-F.** *Diffflugia gramen* Penard. E, lateral view; F, view of aperture with three lobes.

PLATE 6

- Fig. A.** *Diffflugia lithophila* Penard. Lateral view and apertural view.
- Figs. B-C.** *Diffflugia* sp. B, lateral view; C, view of aperture.
- Figs. D-E.** *Diffflugia oblonga* Ehrenberg. D, lateral view; E, view of aperture.

PLATE 7

Figs. A-B. *Diffugia urceolata* Carter. A, lateral view; B, view of aperture with large collar.

Figs. C-E. *Pontigulasia compressa* (Carter). C, lateral view; D, view of aperture; E, lateral view illustrating V-shaped wedge of neck by light microscope.

PLATE 8

Figs. A-B. *Pontigulasia vas* (Leidy). A, lateral view; B, view of aperture.

Figs. C-F. *Euglypha scutigera* Penard. C, lateral view; D, part of surface to show the arrangement of the siliceous plates; E, view of aperture; F, lateral view illustrating cyst by light microscope.

PLATE 1

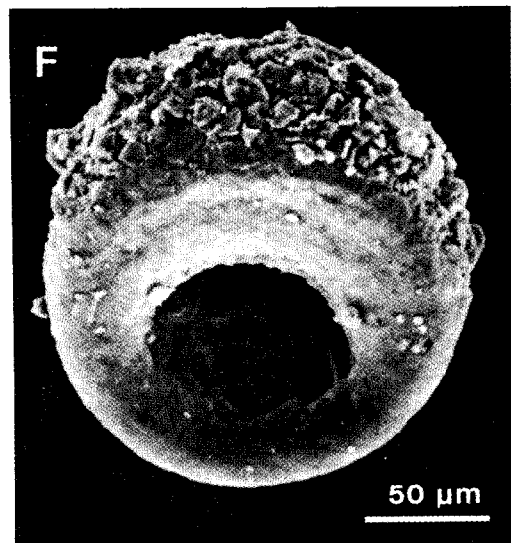
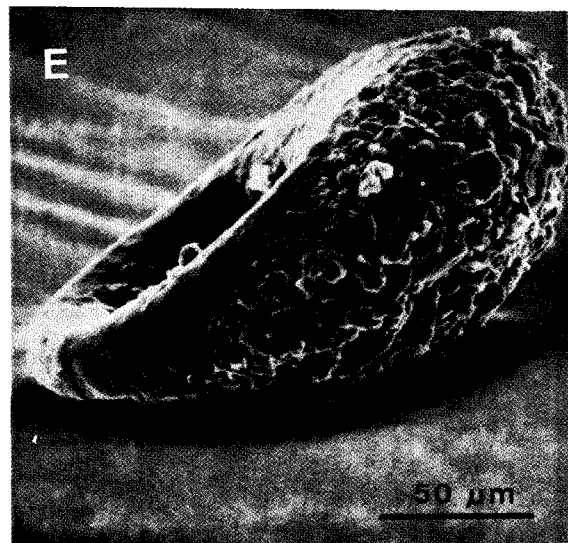
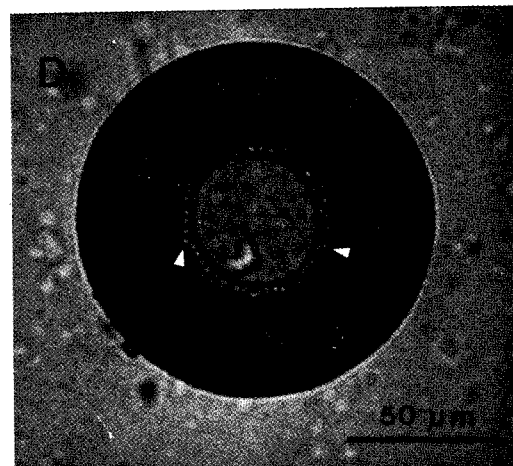
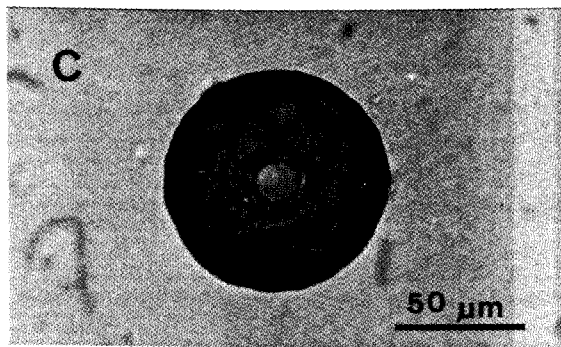
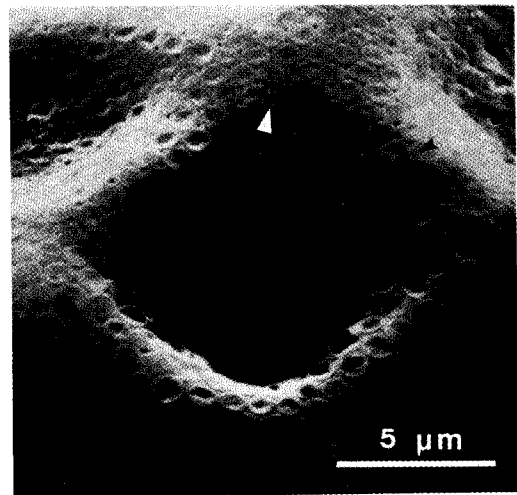
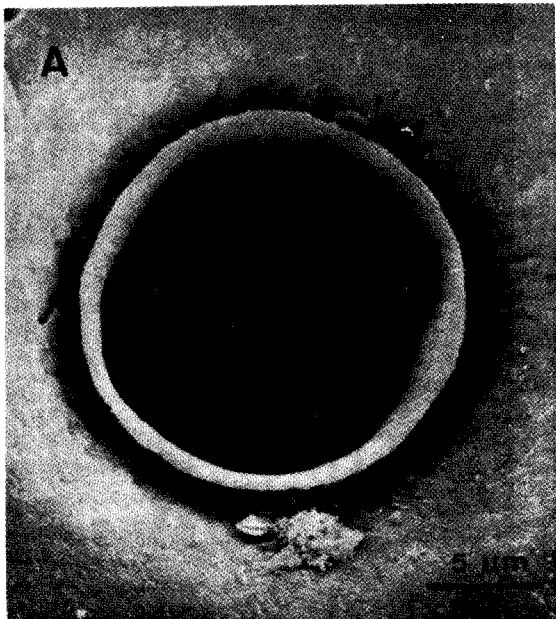


PLATE 2

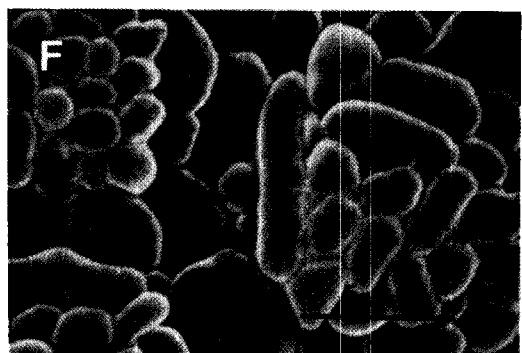
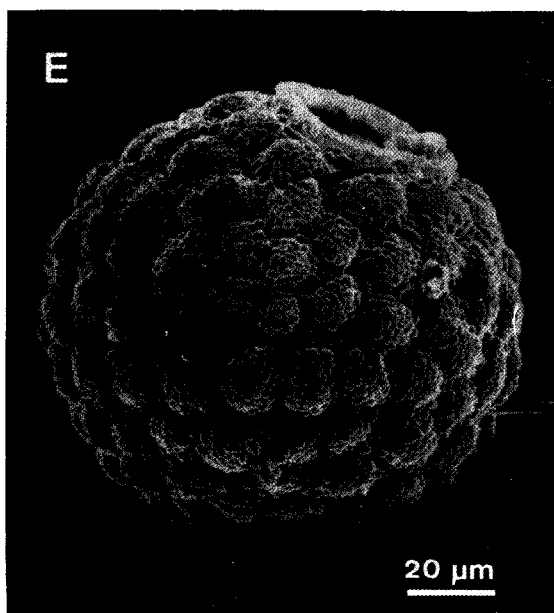
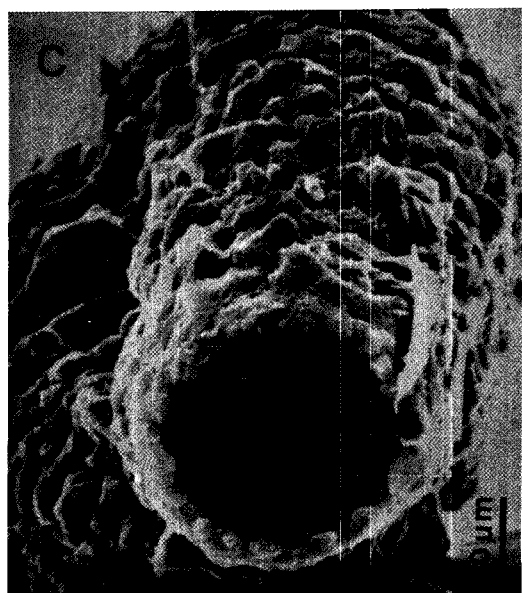
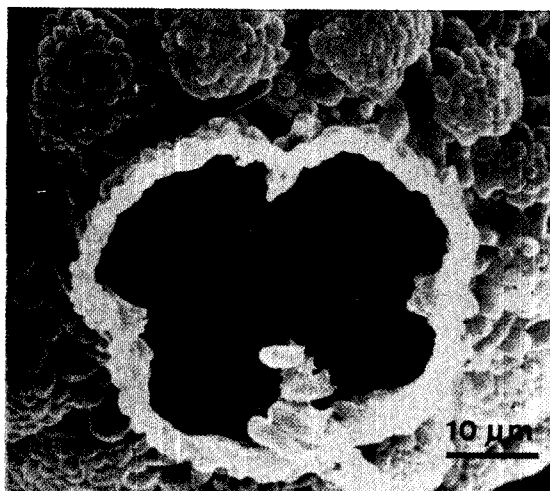
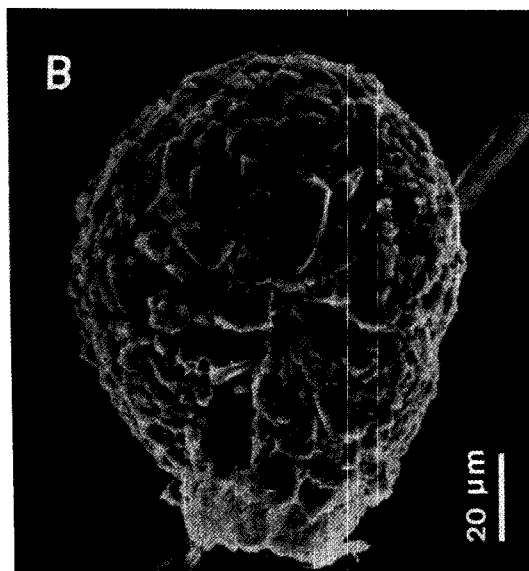
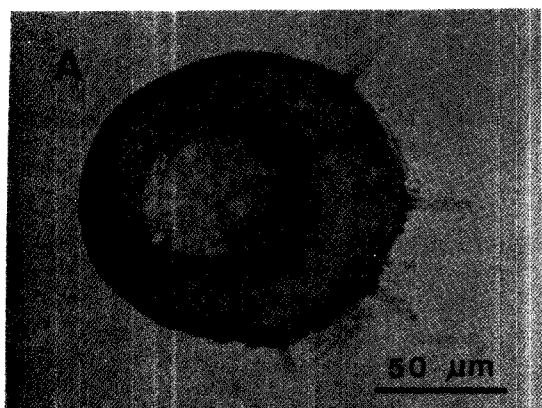


PLATE 3

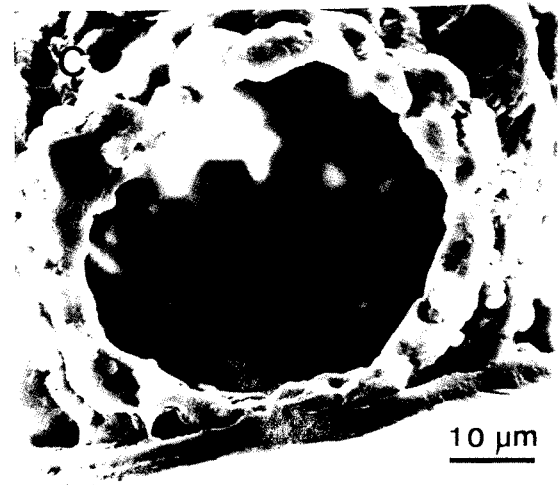
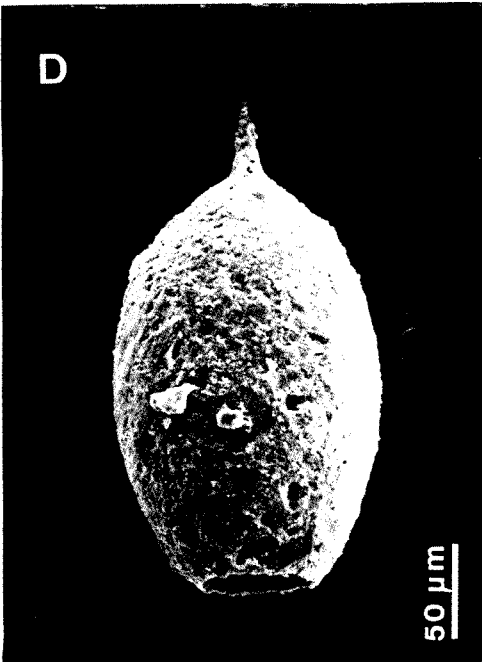
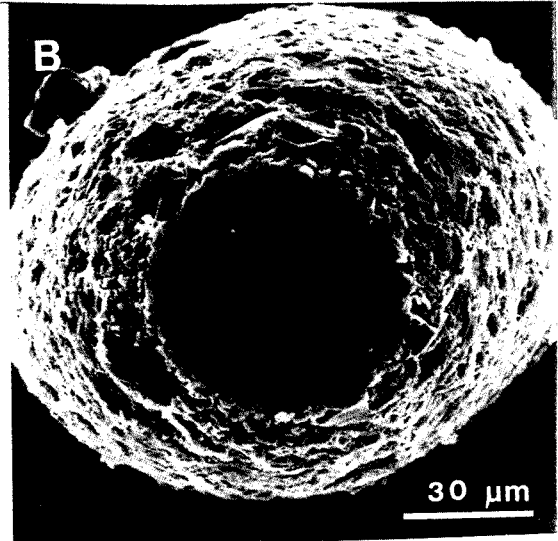
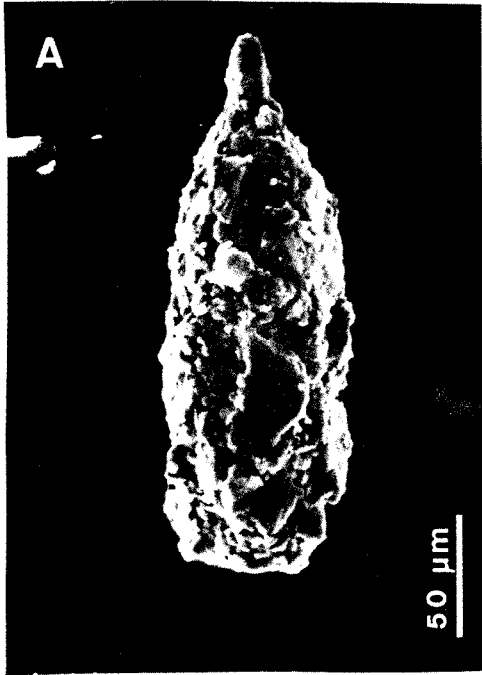


PLATE 4

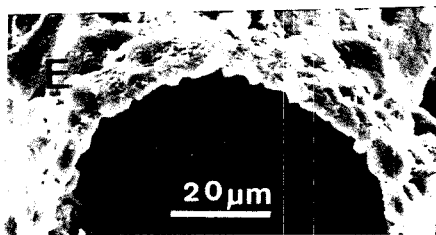
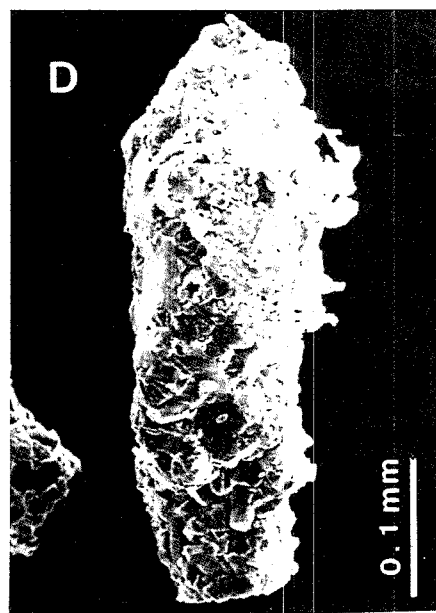
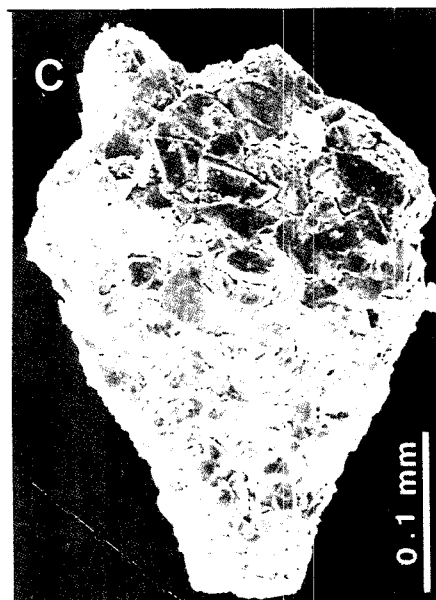
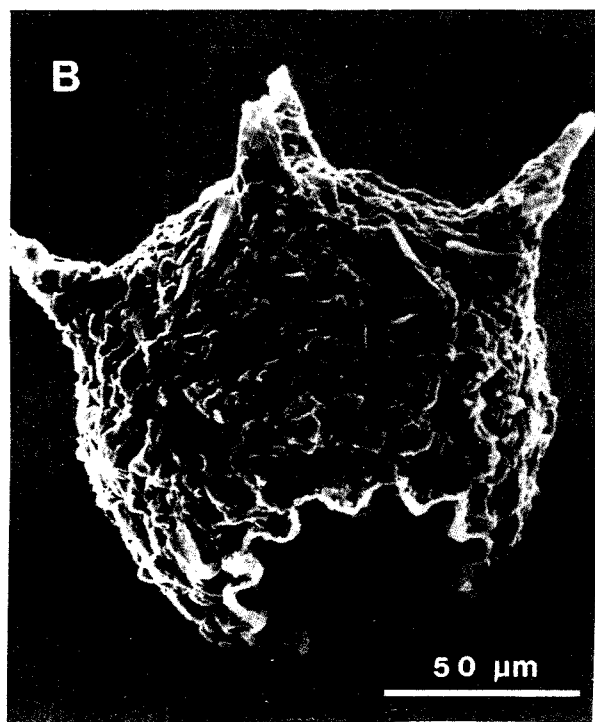
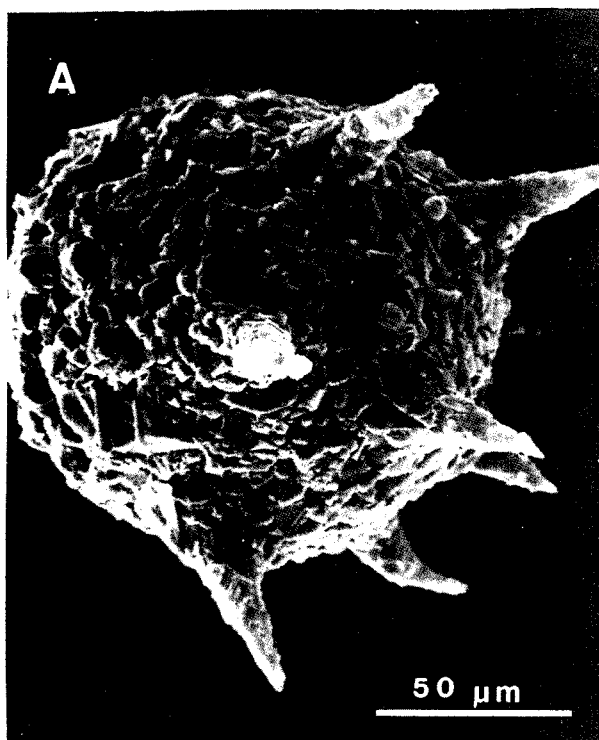


PLATE 5

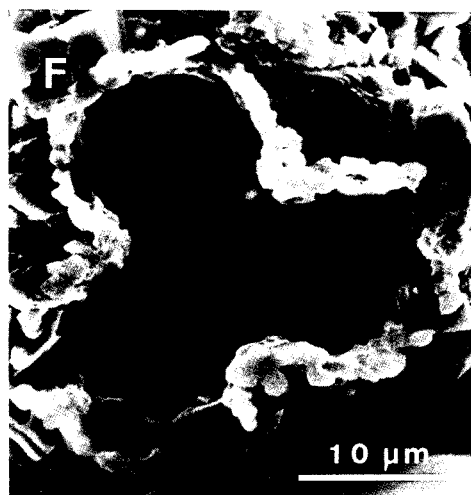
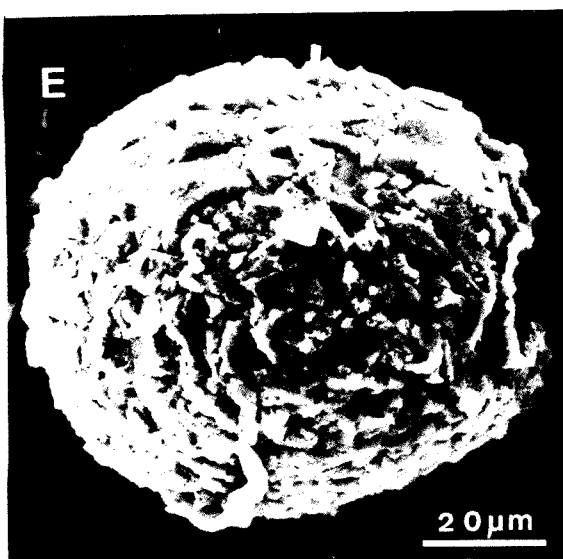
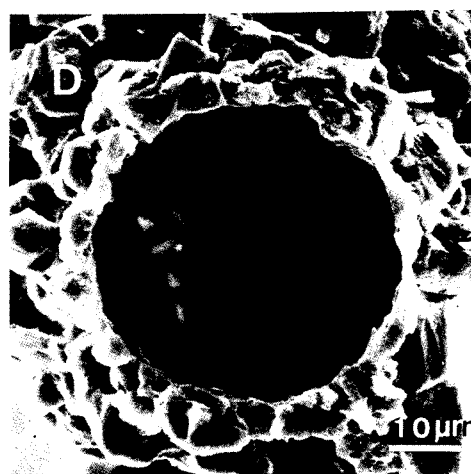
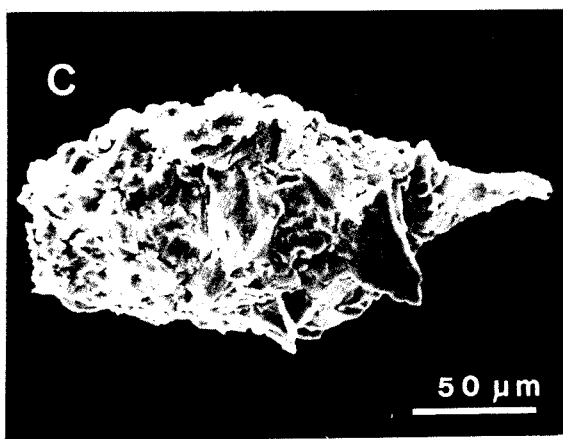
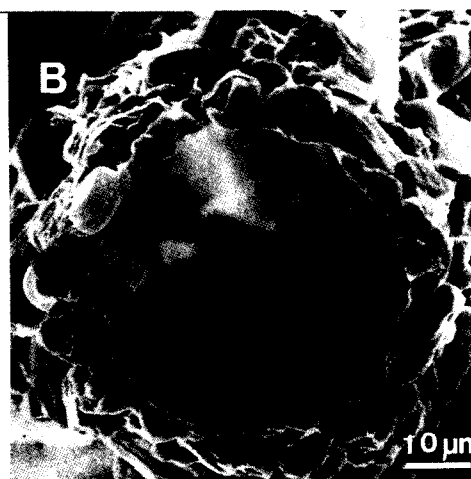
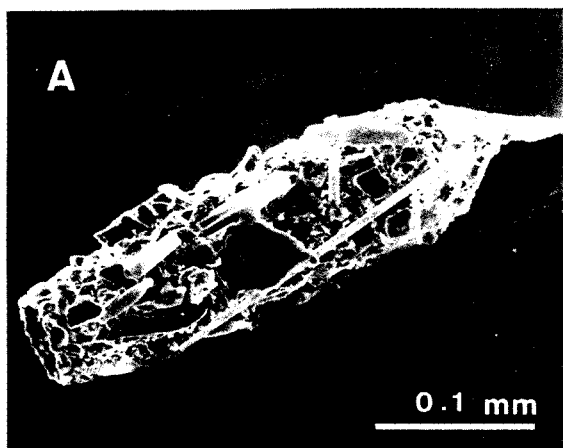


PLATE 6

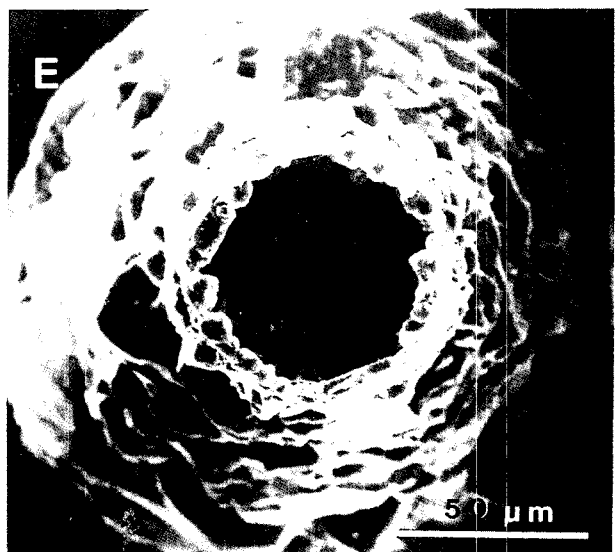
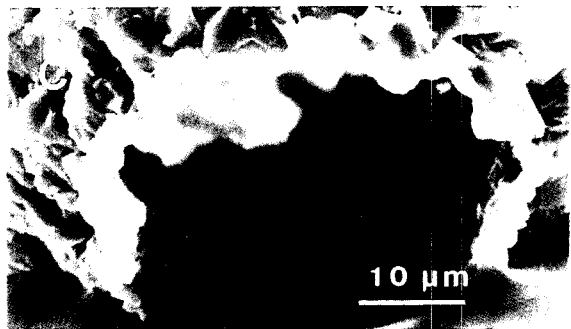
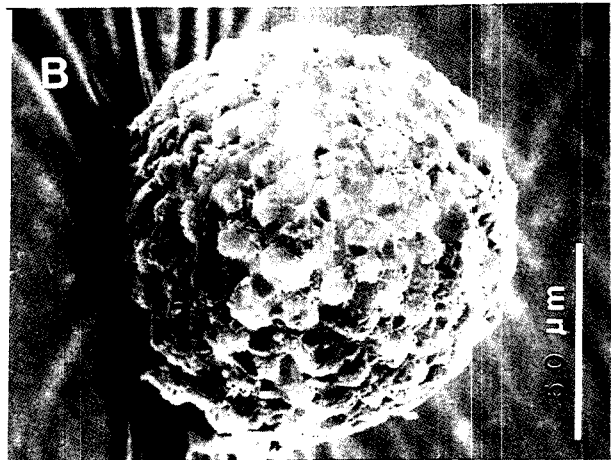
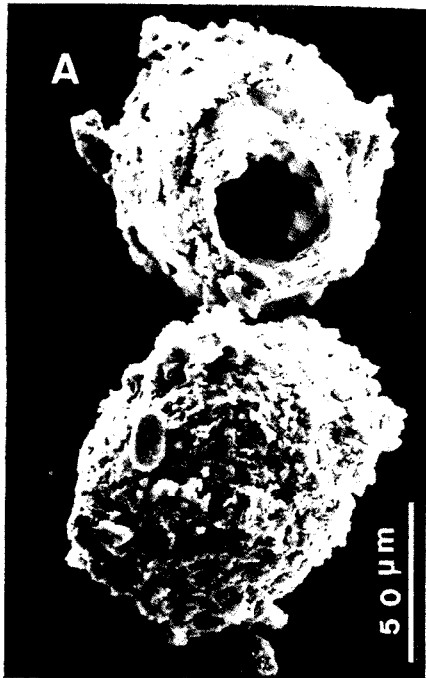


PLATE 7

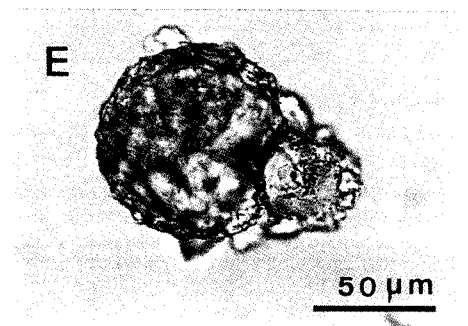
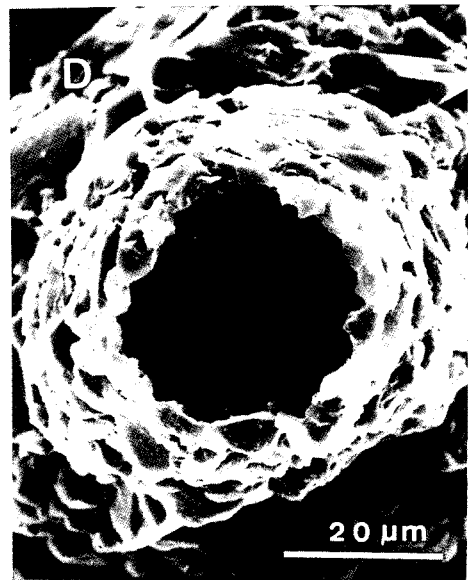
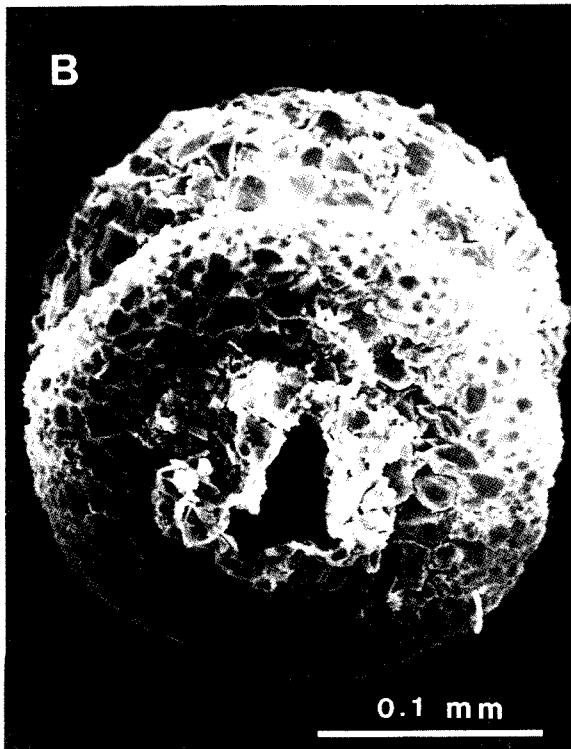
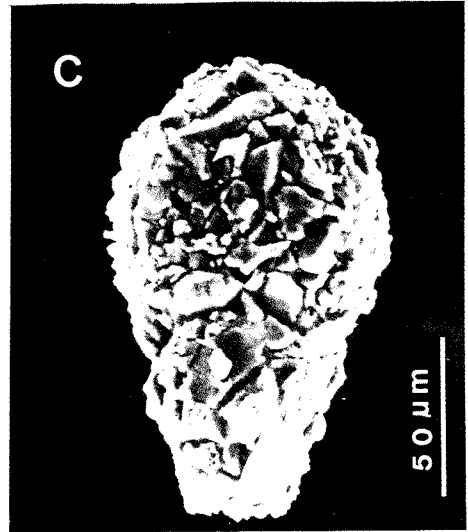
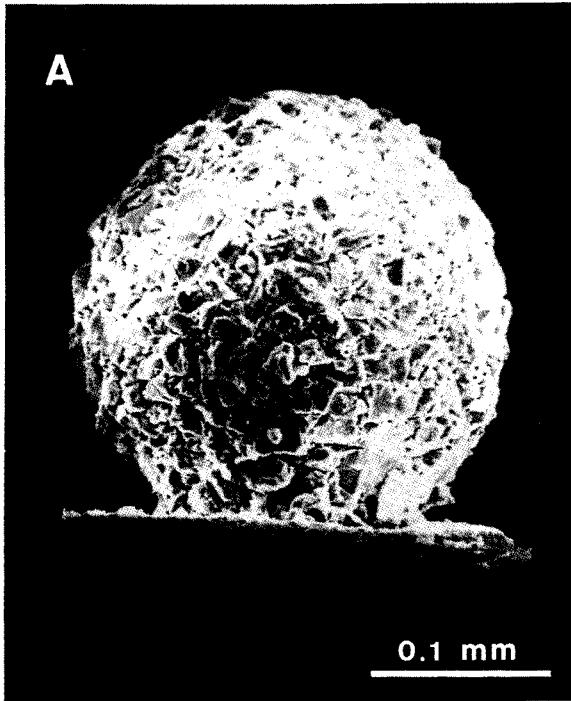


PLATE 8

